# Radio Project

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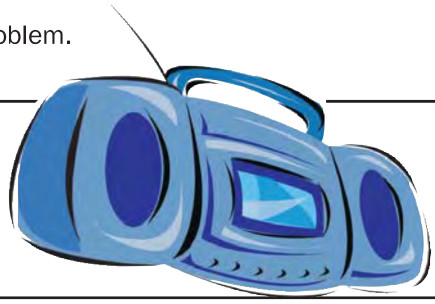
When designers are given a problem to solve, they often break the problem up into a number of smaller activities. This is to make sure that they do not forget any important information that might affect the design.

### Situation:
The situation will give us a general description of the background to the problem.

***An electronics company wish to market a new range of low cost portable radios***



### Design Brief:
The design brief is a summary statement that clearly states the aim of the design project and in a few words states the kind of thing that is needed. For example, “Design a case” is not very helpful to a designer. “Design a case to hold a small radio circuit” gives the designer a clearer focus without applying restrictions.

***Task –*** *Write a design brief for your Radio project*

### Investigation:
Before designing we must find out as much as we can about the situation. Investigation therefore involves collecting information from a variety of sources. When you investigate a situation, it is important for you to think about all the things that might affect your product.

***Task –*** *To help you build up a good background knowledge, investigate the problem.*

### Specification:
Once you have a clear understanding of the problem, you can work out the specification for your Radio. A specification is a list of things that the final design must do. A good specification will list the important features in order of importance.

Specifications are an important part of designing because they provide a check list against which you can review your ideas as you are working. They also give you something against which to evaluate your ideas and your finished product.

For example, ‘needs to hold a battery’ does not give the designer enough information. ‘The case needs to hold a PP3 battery and have easy access so that the battery can be changed’ is a clear statement without restricting the designer.

***Task –***
- *Write a specification for your Radio.*
- *Make a list of all the features you need to include in the design.*
- *Place them in the correct order of importance.*

**Task Sequences**

**Design Brief**
**Investigation**
**Specification**
**Initial Ideas**
**Development**
**Making**
**Evaluation**

# Investigations and Tasks

## Low cost radio for disaster area

There are a number of design situations that require the use of a low cost and low powered radio that is easy to use. Select one of the investigations below as the starting point for the design of your radio.

An earthquake is caused when two parts of the earth's crust slide over each other. These vibrations can be so powerful they can cause large buildings to fall down.

When an earthquake strikes it often paralyses a country's means of communication. People are often left homeless and forced to live in tents because of the risk of aftershocks. In disaster zones after an earthquake people need to be kept informed about essential services like food and shelter and if there is a danger of repeated shock waves.

**Tasks –** 1. Look at one of the major relief agencies that help when disaster strikes around the world. What are the essential pieces of equipment that they have to provide?

2. Find out about the Kobe earthquake that took place in Japan in January 1995.

3. Draw a series of diagrams to help explain how an earthquake occurs. Which area of the world is most prone to earthquakes?

## Sports event commentary

At large sporting events like motor racing or golf tournaments, it is often difficult for spectators to follow all the action, parts of the course may be out of sight or difficult to gain access to. The organisers of the event have negotiated that a live commentary will be broadcast over the radio on popular sports radio stations to help visitors follow the action on other areas of the circuit or course that may be out of sight.

**Tasks –** 1. Identify a sporting event that you would like to provide coverage for and establish the following information:

a. Write a brief history of the event.
b. Draw a logo of the event.
c. How long will the event last and how many people do they expect to attend?
d. Gather together information for broadcasting about one of the main personalities competing at the event.

## New radio station launch

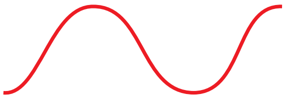
A new commercial community radio station is going to be launched in your area. It will be staffed by people from the community and will carry news and programmes that are based in your area.

**Tasks –** 1. Develop a name and a logo to represent the new community radio station. The logo must include the station's broadcast frequency of 690 kHz AM.
2. Suggest a series of programmes that might be included in the station's broadcast schedule.
3. For one of the programmes you have identified, write a short piece to be included in the programme.

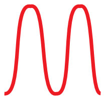
# How it works

Guglielmo Marconi, was the first person to show that invisible radio waves could be used for communication between two places without wires.

Radio waves are part of a wider spectrum of electromagnetic waves. Light is part of this spectrum. The difference between the two is the frequency at which they vibrate. Light has a higher frequency than radio waves.



Radio

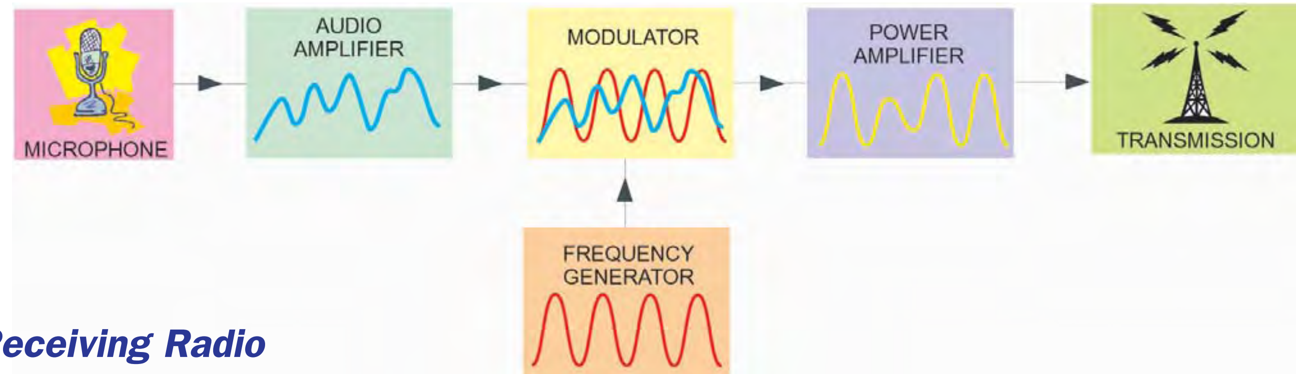


Light

Radio, television and mobile phones, all use electromagnetic waves to transmit information. Each form of communication uses a different frequency to transmit the information. By using a different frequency for each we are able to separate them.

## Transmitting Radio

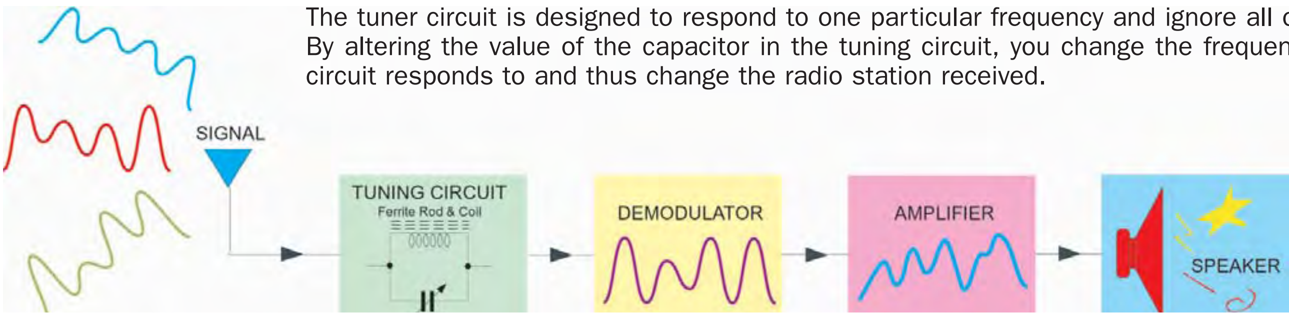
At the transmitter, the signal from the microphone is first amplified. It is then combined with a radio carrier wave, this is called modulation. The modulated signal is then further amplified and transmitted from the aerial.




## Receiving Radio

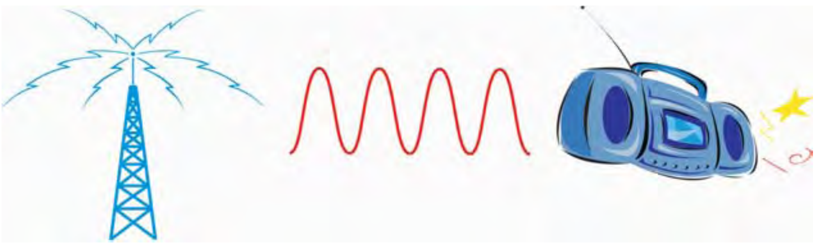
Since we are surrounded by many radio signals, the first task for the radio receiver is to select a particular station from all the others. This is done through the tuning section of the circuit.

The tuner circuit is designed to respond to one particular frequency and ignore all others. By altering the value of the capacitor in the tuning circuit, you change the frequency the circuit responds to and thus change the radio station received.




The tuner section of the circuit causes the radio to receive one of the many radio signals. Now the radio has to extract the voice or music from the carrier wave. This is done with part of the radio called a demodulator. Demodulation removes the original sound wave from the carrier wave.

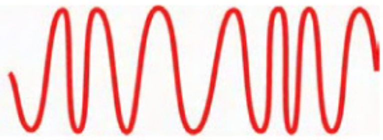
Since the sound is very weak it needs amplification so that we can hear it. The final signal is then fed to a speaker where the original voice or music can be heard again.



If you look at a radio you will see that there are usually two types of radio signal that it can receive, AM and FM.

**AM (amplitude modulated)**

**FM (frequency modulated)**

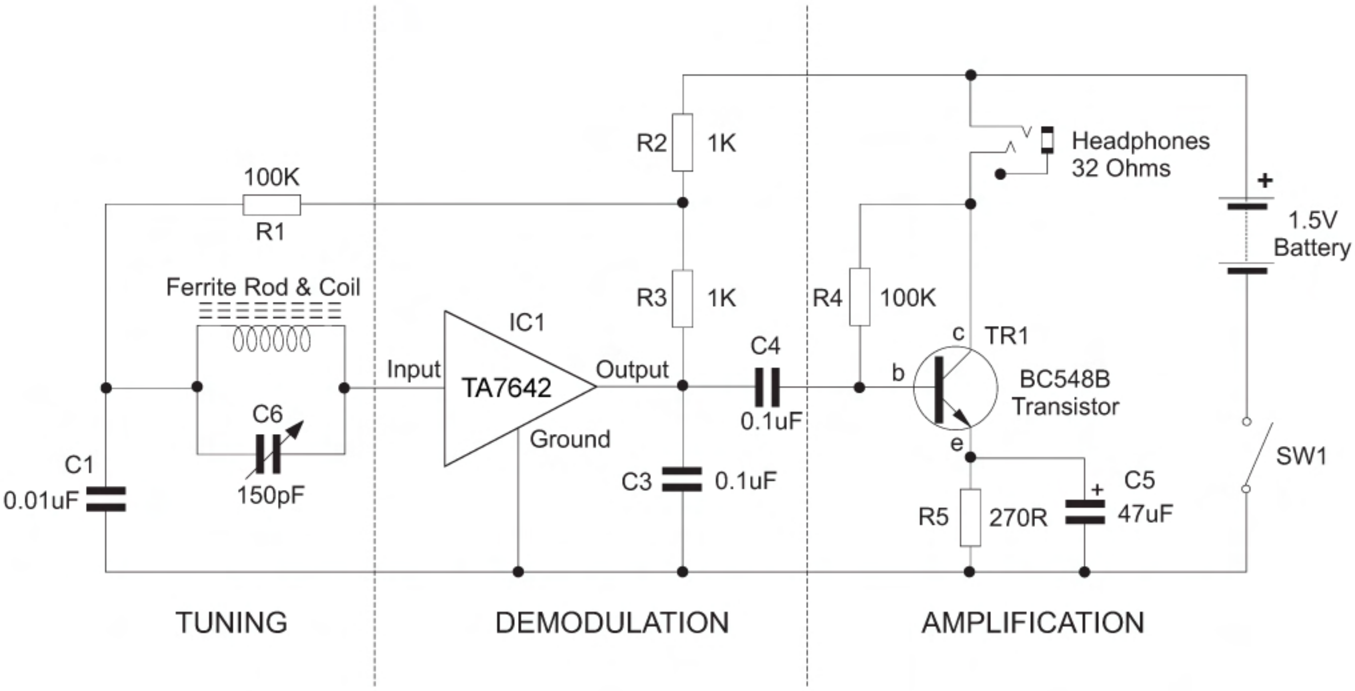


## *Amplitude modulation (AM)*

AM is easier to transmit, but can be affected by electrical interference from devices like a switch. Tall buildings or hills also affect AM radio reception.

## *Frequency modulation (FM)*

The FM wave is more difficult to transmit, but it does not suffer interference as much. FM carrier waves are higher in frequency than AM.




The diagram above shows the radio circuit used in the project. The ferrite rod and variable capacitor are to tune the circuit to the desired radio station. The TA7642 demodulates the signal and the BC548 transistor amplifies the output to the headphones.

***Tasks –*** 1. Why do you think the use of radio waves to broadcast is very closely controlled?

2. Find out the frequencies that the following devices operate on:
   a) Microwave ovens
   b) Police Radios
   c) Radio controlled models
   d) Mobile phones

3. List your five favourite radio stations and the frequencies they transmit on.

# The development of radio

Heinrich Hertz was the first to discover electro-magnetic waves in 1887, but it was not until 1894 when Andrew Muirhead and Sir Oliver Lodge demonstrated the first wireless telegraphy at Oxford, that a use for electro-magnetic waves was found.

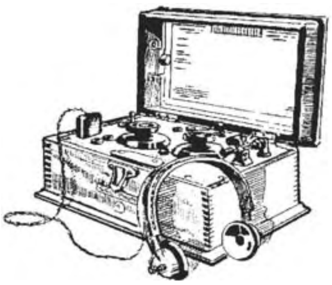
Guglielmo Marconi was the first person to realise the commercial potential of radio. He patented the method of wireless telegraphy in 1897 that allowed morse code to be transmitted over the airwaves. The invention was mostly used to enable communication between ships and shore.


The sinking of the Titanic in 1912 showed the usefulness of the new technology, when the ship sent distress signals over the air, that helped in the survival of over 700 people.

One of the earliest radios was installed at Queen Victoria’s home on the Isle of Wight so that she could communicate with the Prince of Wales whilst he was recovering from illness on the Royal Yacht moored in Cowes Harbour.

## Crystal radios

The first radios available for popular use were called crystal sets. The drawing shows an early Secophone set, made in 1922. The set is housed in a wooden case and listened to by a set of headphones, It could be tuned to the new medium wave transmitters being built around the country.



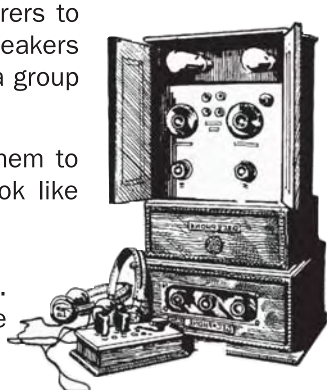
## Public broadcasting

There was great interest in radio when it was first introduced. People could now listen to live news and music whilst at home. Many early listeners built their own crystal radios.

The manufacturers of early radios contributed to the development of public broadcasting by asking the government to let them establish radio stations. As a result, the Post Office called a meeting which led, in 1922, to the formation of a broadcasting company, the BBC.

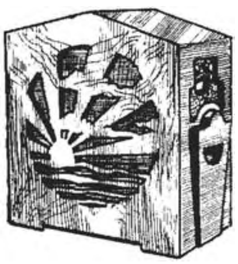
## Valve radios

The introduction of valves to radio design allowed the manufacturers to build more powerful radios. The higher output meant that speakers could now be added and the radios could then be listened to by a group of people in a room.



Radios began to take pride of place in homes. People wanted them to blend with their existing furniture, so radio casing started to look like furniture of the time.

The style of radios developed as the technology inside improved. As the size of the valves gradually became smaller so did the size the radios.



As the number of radio manufacturers increased so did the variety of designs on offer. Radios began to be mass produced using new materials like Bakelite. This allowed the cost to be reduced and as a result, radios became more widely available.

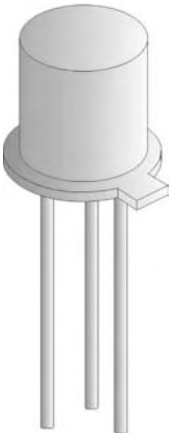
Bakelite was an early form of plastic. It allowed the designers to create and mould new shapes that previously they were unable to achieve with more traditional materials like wood.

The 1940s were the era of streamlined design and Art Deco styling. Like all objects of the era radios reflected this style.

The radio was steadily becoming the focus of family entertainment in the home, taking over from the gramophone. Families would gather to listen to popular shows and organise their evenings around these broadcasts. News items and special events could now be broadcast live to millions of listeners around the world.

## *Transistor radios*

The transistor was invented in 1947, at Bell Telephone Laboratories. It was smaller, used less electricity and operated more reliably than valves.



The Regency TR-1 was the first transistor radio available in 1954 costing around £30.

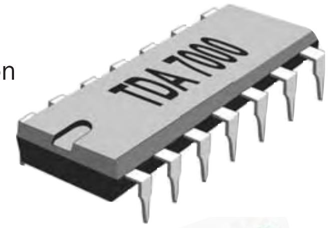

The development of transistor radios changed the way music could be listened to. Transistors made radios smaller and as a result more portable and affordable. Young listeners began to buy the new transistor radios to listen to their own music.

The transistor radio transformed the social use of radio. Sets were now inexpensive and highly portable. Radios were no longer a piece of furniture but a personal item that could be carried everywhere, and as a result the demand for radios increased.

## *IC based radios*

In 1958 the integrated circuit was developed by Texas Instruments. It was now possible to place all the components of an electronic circuit on a small piece of silicon.

The use of small ICs has allowed the design of radios to change dramatically. The design of the case is no longer defined by the circuit it contains. This has allowed designers to develop a whole new range of novel and interesting shapes to contain radios.




The development of IC manufacturing has resulted in surface mounted ICs and 'Chip on board' constructed radios that have allowed the size of radios to shrink even more.

The diagram on the right shows a mini radio that sells for a few pounds and fits onto a key ring!

## *Future of radio*

The 21st Century has seen the introduction of digital radio. Analogue radio signals frequently suffer from interference and distortion. Digital radio signals do not suffer from interference.

With digital radio all the transmitters use the same frequency. This means you do not have to re-tune as you move location.

A digital signal can also carry several radio programmes and data simultaneously, allowing you to see text and pictures with your radio programme.

**Tasks –**
1. Draw a time line using pictures and words to show the main points in the history of radio.
2. The technology in radio design is improving all the time and as a result the design of radios is getting smaller. Using modelling foam sculpt a fun shaped radio that could be carried as a piece of adornment. Sketch out your designs first and then model your designs. Do not forget to paint them.
3. Write a short piece about how the Internet is changing the way we listen to music.

# Initial ideas

Once you have written a specification, the next stage is to draw some initial ideas. Designers try to come up with as many ideas as possible. Even if you think the idea might be a little silly, you should include it because it may be useful later.

Your specification will act as a guide for your ideas. Try to think of the main features you need to include whilst you are drawing.

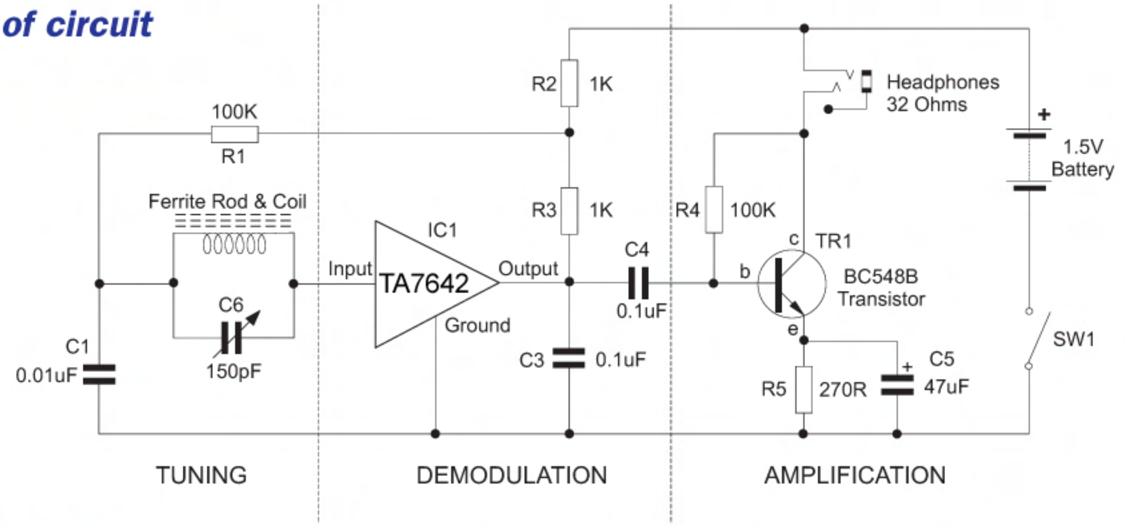
**Task –** *Draw a range of ideas for the casing design of your Radio project.*

**Do not make your designs too complicated with lots of small cut and turns.**
**This will prove difficult for you to cut out.**

# Circuit construction

The circuit can be divided into three sections. The first section comprising the ferrite rod and the variable capacitor is for tuning the radio to the desired station frequency. The TA7642 removes the audio signal from the transmitting carrier signal. The last section based on the BC548B transistor is to amplify the audio signal so that it can be heard through the headphones.

## Construction of circuit

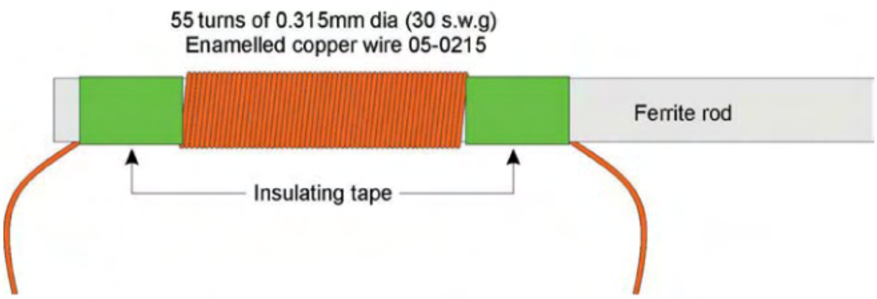




You will need to collect together the following equipment before you start construction of your circuit:

- Soldering equipment set
- Printed circuit board
- Components: IC TA7642, transistor BC548B, 150pF variable tuning capacitor, ferrite rod, 2.5m of 0.315mm enamelled copper wire, two 100K resistors (brown, black, yellow), two 1K resistors (brown, black, red), one 270R resistor (red, violet, brown), Ultra-miniature slide switch, two 100nF capacitors, one 10nF capacitor, one 47uF capacitor, headphone socket, AA battery holder.

## Procedure for circuit construction

1. Start the building of your radio by winding the coil. The coil needs approximately **55** turns of 0.315mm diameter enamelled copper wire on a 100mm long ferrite rod. **The windings should measure approximately 25mm wide.**

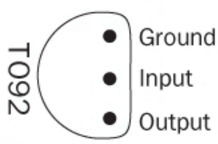


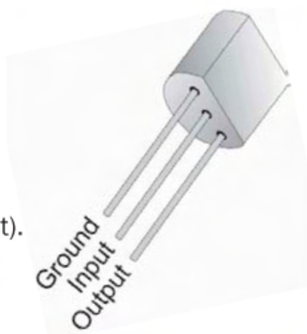

Start winding close to one end by securing the enamelled wire by a piece of insulating tape. Leave approximately 100mm for attachment. The quality of reception is dependent upon the care taken in winding the aerial.

The signal reception will vary dependent upon location and is better away from large buildings that can distort the signal.

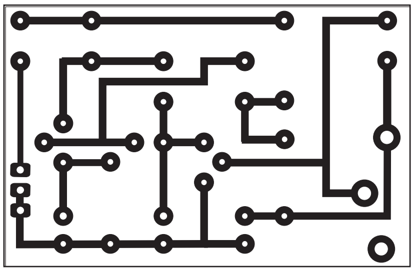
Wind the wire tightly around the ferrite rod, taking care to keep the coil together and not to overlap the windings. To help hold the windings in place a piece of double sided tape can be placed on the ferrite rod. **Before soldering the aerial to the circuit board, you will need to scrape off the enamel coating from the ends of the wire.**

2. Solder the resistors in place.
3. Solder the smaller capacitors in place.
4. Solder the BC548B into the circuit.
5. Solder the TA7642 radio IC in place.
6. Solder the variable tuning capacitor into position.
7. Attach the connecting wires to the headphones socket.
8. Attach the headphones socket to the circuit board.
9. Solder the aerial in place. (Make sure you remove the coating from the enamelled wire first).
10. Attach the AA battery holder to the circuit board.

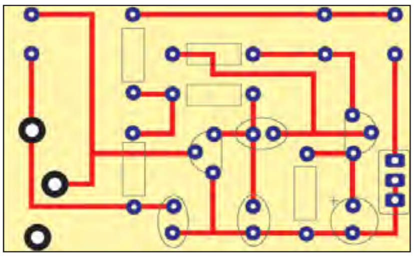


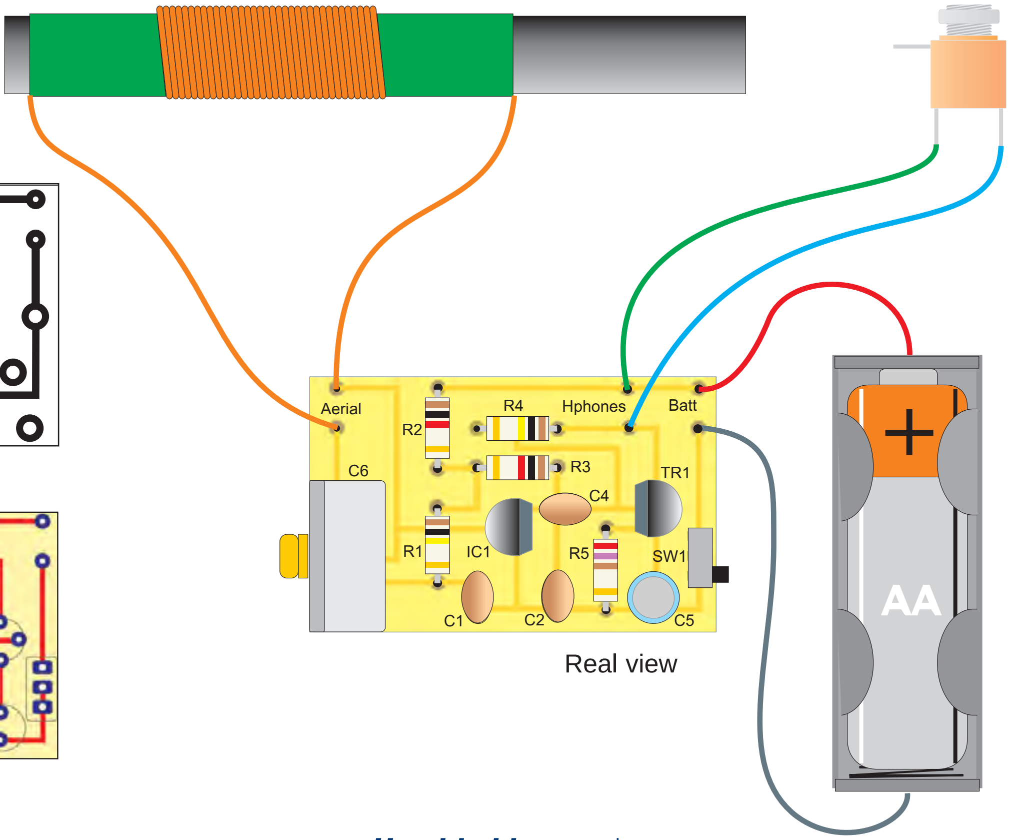



Track side

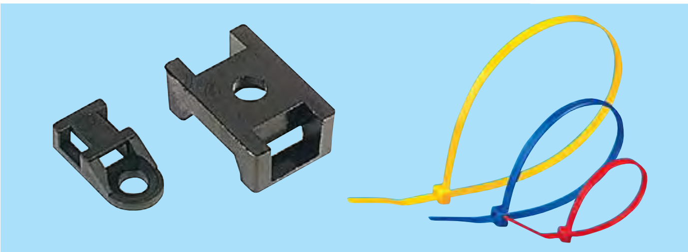


Transparent view






Real view



Extracts taken from Rapid Education Catalogue April 2001 - March 2002. Please see latest catalogue for current pricing.

## *Hand held cases**

Two hand held cases with battery compartments, ideal for portable equipment. The battery compartments have removable lids and can accommodate a single PP3 battery. The cases are moulded in ABS with the two halves being held together by screws, supplied. The bottom case has moulded-in bosses for easy installation of PCB and hardware. Colour: black.

| *Length (mm)* | *Width (mm)* | *Height (mm)* | *Order code* | *1+* | *25+* | *100+* |
|---|---|---|---|---|---|---|
| *145* | *61* | *28* | **30-0285** | **2.10** | **1.78** | **1.57** |
| *190* | *81* | *34* | **30-0290** | **2.95** | **2.50** | **2.18** |

## *Circuit fixtures*

It is important to avoid damaging your circuit by securing it in the case properly. You must also be able to change components if they become damaged.

There are a large number of manufactured cases that can be used to contain your prototype circuits. These are available in a variety of materials and styles.

***Tasks –***

1. Measure all the separate components that are going to make up your Radio e.g. Aerial, headphones socket, circuit board, battery, etc. Work out the optimum space needed to contain the circuit.

2. Use a series of sketches to show how the sections of your Radio are to be held in your case design.

3. Use the Rapid Electronics catalogue to select a suitable case for your Radio circuit giving reasons for your selection.

4. Draw a series of initial ideas for a vacuum formed case to hold the Radio circuit. Think carefully about the following:
   a) How the circuit is to be held in the case.
   b) How much space is required to house the circuit.
   c) How to gain access to change the battery.

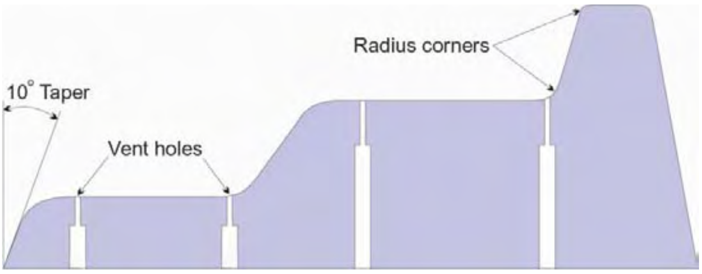
Present your ideas as a series of sketch ideas, highlighting those you feel are the most interesting with colour.

# Case design

There are a variety of methods of containing your electronic products. The choice depends on your design requirements.

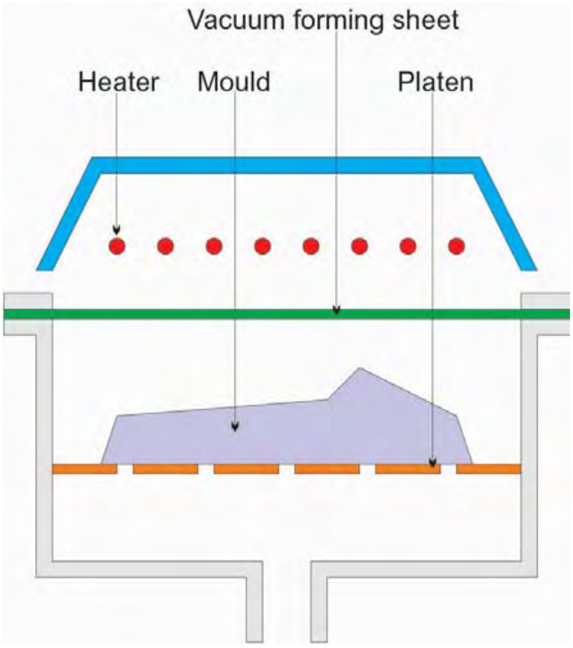
Vacuum forming is an ideal method for creating cases to hold your electronic products. High impact Polystyrene or ABS make good case moulding material. The first stage is to design and make a mould.

There are a number of important features that need to be included to make a good mould design:



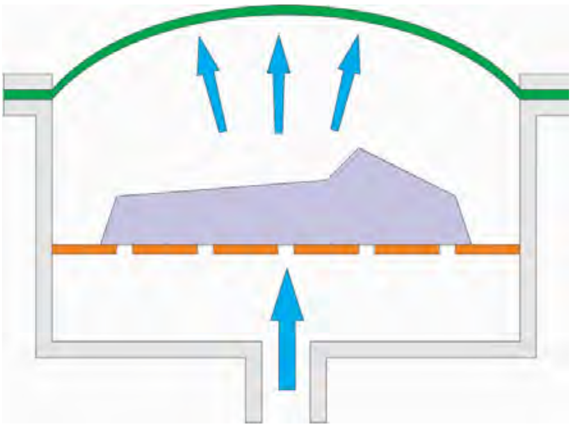

1. The mould sides must be tapered to allow the mould to be removed.
2. Vent holes need to be drilled to help draw the plastic when the vacuum is created.
3. There should be no undercuts, which will prevent the moulding being removed from the mould.
4. The mould needs a high standard of finish. Any marks will appear on the surface of the moulding.

## Vacuum forming process



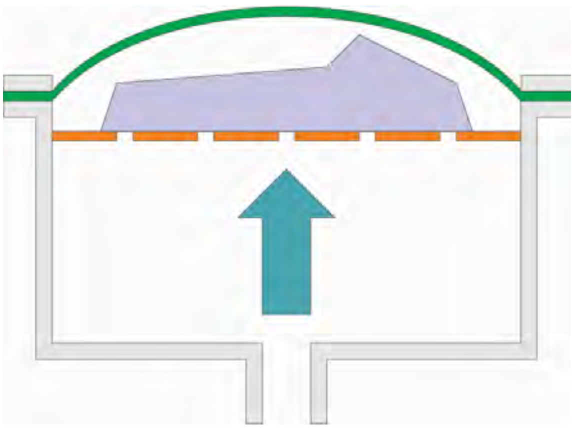

The vacuum forming sheet is first clamped into position around its edge by an airtight seal. The sheet is then heated from above by the radiant heaters in the machine's hood.

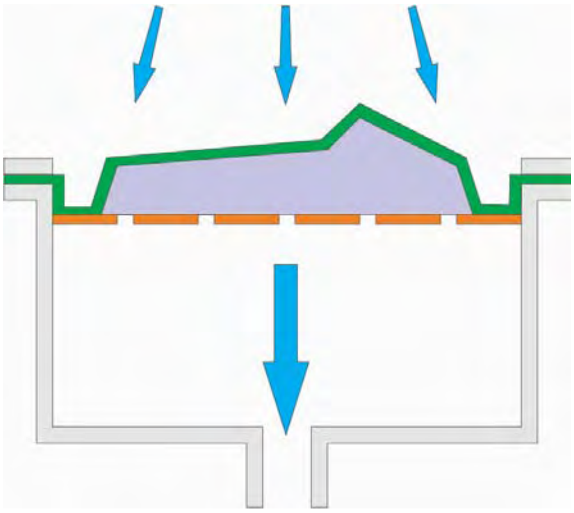
When the sheet becomes soft and pliable, between 150°-170° the heating hood is removed.



When the sheet is pliable and the heater has been removed, air is blown in under the sheet to stretch it. This is done to reduce the thinning on the moulding. The platen is now raised into the blown sheet.

The air is then drawn from under the mould, creating a vacuum. The atmospheric air pressure above then forces the pliable sheet of plastic over the mould taking up its detailed shape.





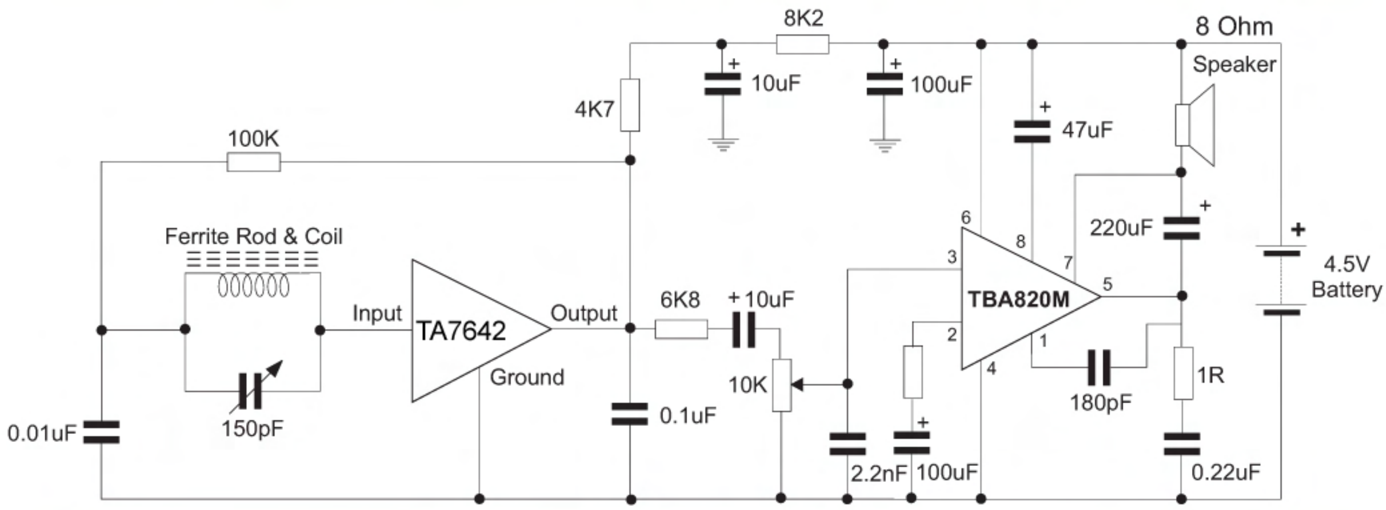
# Development

**Task –** In the box below draw and colour your final design for your Radio case. Take care not to make the design too complicated since this will prove difficult to cut out. Use the 'Case Construction' activity sheet for guidance on positioning the circuit.

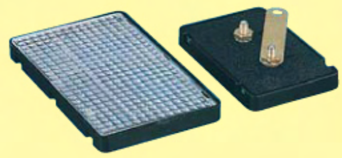
# Product Development

After testing and evaluating a new design, designers are frequently asked to make changes or improvements to their design. This is a process they may go through a number of times, testing and improving the product before it is finally manufactured.

**Task –** 1. A manufacturer is interested in your designs. However, market research suggests that a radio with a small speaker is needed. Using the circuit below, produce a series of alternative casing designs for a radio with a speaker.




**Tasks –** 2. A company wish to market your radio design and power it by solar cells.
Solar cells are made from thin slices of crystalline silicon, and they convert solar radiation directly into electricity. Since the radio operates from a single AA 1.5V battery and consumes a very small current, it is ideal for solar power.



a) The Solar energy kit (order code 37-0420) will allow you to experiment with powering your radio by solar energy. You will be able to experiment with a variety of lighting conditions and to establish the optimum number of cells required.

b. Find out more about how solar cells work. You can either use books or look on the Internet. A good starting point is the following address:

**www.eren.doe.gov/pv**

c. What are the advantages and disadvantages of powering the radio by solar energy?

d. Whilst watching a television programme in September 1991 about the spread of AIDS in Africa, Trevor Baylis, an inventor, had an inspirational idea for a radio. Find out about the work of the inventor Trevor Baylis and his invention of the Freeplay Radio.

# Evaluation

Evaluation is an important part of the design process. It is used by designers to check they have produced an effective design with all the features they identified in the specification. When you are evaluating a product you are trying to find out both its good and poor features.

Your own opinions are important, but you must also get some other people's opinions as well. They may notice qualities you are not aware of.

**Tasks –** 1. Evaluate your Radio project by establishing if it meets your specification.
2. Look at your specification and write down in the boxes below two features to establish the quality of your Radio.

1.

2.

**Task –** Sketch how your final Radio design could be improved.

# Progress Diary

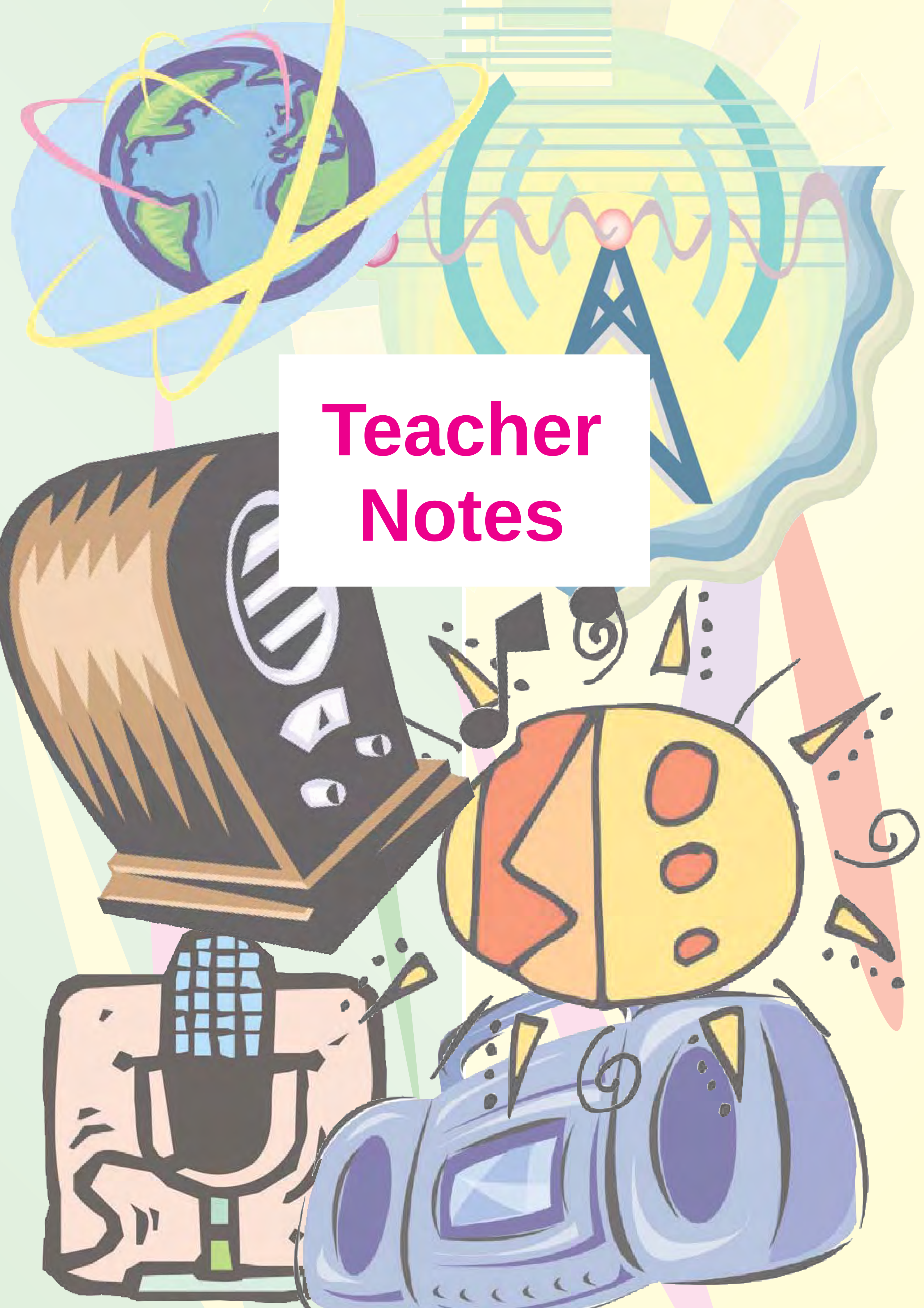
Each week, write a short paragraph about the work you have done. As well as commenting on good aspects of the lesson, try to comment on work that has not gone so well, or that you did not fully understand.

When designing, it is also important to think ahead. Write down in the second section what work you anticipate doing next week on your project.

| | |
|---|---|
| **Week 1** | TODAY_____________ |
| | NEXT LESSON |
| **Week 2** | TODAY_____________ |
| | NEXT LESSON |
| **Week 3** | TODAY_____________ |
| | NEXT LESSON |
| **Week 4** | TODAY_____________ |
| | NEXT LESSON |
| **Week 5** | TODAY_____________ |
| | NEXT LESSON |
| **Week 6** | TODAY_____________ |
| | FINAL COMMENT |

**Teacher comments**

# Teacher Notes



# Teacher information

## Introduction

The radio project has been written to introduce students to the popular subject of communication through radio. The project will look at tuning circuits along with modulation and signal amplification. The work is suitable for KS3/4 students. Emphasis has been placed on providing a means to a quality design outcome.

A key feature of the teaching material is that in addition to providing a student resource, it also contains detailed teacher support notes for guidance. **This teaching pack has been designed to be photocopied.** A number of the activity sheets can be used in isolation from the project. Included in the material are a series of structured homework assignments to support the work in class.

A series of lesson plans have been included based on teacher experience. However, the detailed project organisation will depend upon timetable, facilities and student needs. The practical work should be possible in a typical secondary based workshop.

## Aims and objectives

The project is to design and make a low powered radio that can be used in a variety of design contexts. The project will enable students to experience the design and manufacture of a simple radio.

**CONCEPTS:**

- Electronic tuning circuits.
- Design and manufacture.
- Evaluation.

**OBJECTIVES:**

Pupils should understand:

- The need to investigate the background to a problem.
- How to select appropriate components to build simple electronic circuits.
- The importance of planned manufacture.
- How to improve a product by evaluation.

**SCIENCE OPPORTUNITIES:**

- Understanding of circuit theory.
- Concepts of electromagnetic waves, frequency and sound.

**MATHS OPPORTUNITIES:**

- Accurate measurement and marking out.

**ICT OPPORTUNITIES:**

- CAD for designing case developments.
- Graphic packages to help generate design ideas.

**ART OPPORTUNITIES:**

- Drawing and presentational techniques to help represent ideas for casing designs.

# Lesson Plans

## WEEK 1 INTRODUCTION TO DESIGN SITUATIONS

**Aim:**

- Introduction of situation.
- Investigate Radio situations and identify one of the three suitable areas for focus work.
- Write Design Brief.

**Student:**

- Investigate chosen situation.
- Write design brief.

**Teacher:**

- Help identify suitable situation selection through background discussions.
- Assist in the writing of the design brief.
- Advice on organisation of information gained from Radio Investigations sheet.

**Demonstrations:**

- A range of Radios.
- Investigation of methods of tuning and power supply used in examples.
- Project radio.

**Resources:**

- Examples of Radios (if available).
- Example of a completed Radio project.
- "Radio project introduction" sheet.
- "Investigation and tasks " information and activity sheet.
- Access to Library/books/Internet for research information.

**Homework**:

- Research chosen design situations for Radio.
- Selected questions from "Investigations" sheet.
- Diary record.

## WEEK 2 RADIO THEORY AND HISTORY

**Aim:**

- Understanding of simple radio transmission and reception.
- Look at the development of technology in radio design
- Examine the changes in radio style

**Student:**

- Simple radio experiments.
- Questions based on activity sheets.

**Teacher:**

- Introduction to radio theory.
- Introduction to developmental radio history.
- Discussion on how radio style has changed with technology available.
- Assistance with work on activity sheets.

**Demonstrations:**

- Simple radio theory experiments.
- Older style radio technology and style.
- Construction techniques and materials used.

**Resources:**

- "How it works" activity sheet.
- "The development of radio" activity sheet.
- Selection of radio styles.

**Homework**:

- Selected questions from activity sheets.
- Diary record.

# Lesson Plans

## WEEK 3 CONTAINMENT DESIGN

**Aim:**

- Establish specification.
- Generate initial ideas for case design.
- Develop graphical communication and presentation skills.

**Student:**

- Write specification.
- Establish range of initial ideas.

**Teacher:**

- Discuss specification.
- Guide students through generation and development of ideas.
- Advice on presentation techniques and layout of work.

**Demonstrations:**

- Variety of presentation techniques suitable for communicating ideas.
- Methods of manufacturing case.

**Resources:**

- "Initial ideas" activity sheet.
- Component parts of radio for measurement.
- Drawing materials.
- Vacuum forming demonstration material.

**Homework:**

- Completion of unfinished design work.
- Diary record.

## WEEK 4 CIRCUIT ASSEMBLY

**Aim:**

- Review of safe working practices in the workshop.
- Design and production of PCBs.
- Students to start manufacturing Radio circuit.

**Student:**

- Manufacture Radio project.

**Teacher:**

- Go through safety in the workshop with students based on equipment to be used.
- Review the design, manufacture of PCBs and soldering.
- Provide assistance to students to start manufacturing Radio.

**Demonstrations:**

- Review soldering.
- Manufacturing a PCB.
- Winding aerial.

**Resources:**

- Class set for five students, order code **70-0110**, which includes:
  *IC TA7642 transistor BC548B, 150pF variable tuning capacitor, ferrite rod, 2.5m of 0.315mm enamelled copper wire, two 100K resistors (brown, black, yellow), two 1K resistors (brown, black, red), one 270R resistor (red, violet, brown), Ultra-miniature slide switch, two 100nF capacitors, one 10nF capacitor, one 47uF capacitor, headphone socket, AA battery holder.*

- Class set of five printed circuit boards (pre-drilled), order code **70-0120**.
- Soldering tools.
- Workshop tools.

**Homework:**

- Circuit fixture exercises.
- Diary record.

# Lesson Plans

## WEEK 5 CASING MANUFACTURE/ASSEMBLY
**(This section will need additional time if students are to manufacture their own case designs).**

**Aim:**
- Complete construction of Radio.
- Assemble Radio.
- Examine alternative methods for casing circuit.

**Student:**
- Complete any unfinished circuit construction.
- House circuit in case.

**Teacher:**
- Provide support to help students finish the soldering of their PCB.
- Assist students in the fitting of their circuits into the case.
- Examine alternative methods of case construction.

**Demonstrations:**
- How to assemble circuit into case.
- Vacuum forming.

**Resources:**
- Examples to use in demonstrations for assembly of circuit into case.
- Cases for students.
- Vacuum forming machine, suitable mould and sheet material.
- Workshop tools for cutting, shaping and finishing.

**Homework**:
- Diary record.

## WEEK 6 EVALUATION
**Aim:**
- Completion of Radio assembly.
- Evaluation of Radio project and student progress.

**Students:**
- Completion of project assembly.
- Evaluation against specification.
- If sufficient time – Extension exercises based on radio circuit developments.

**Teacher:**
- Help with final project assembly.
- Discussion on important features to include in project evaluations.
- Guidance on extension activity.

**Demonstrations:**
- Project evaluation exercise.

**Resources:**
- "Evaluation" activity sheets.
- "Product Development" activity sheets.

**Homework:**
- Diary record and final project evaluation.
- Extension activity.

# NATIONAL CURRICULUM 2000

## *Programme of Study Key Stage 3*

During key stage 3 pupils use a wide range of materials to design and make products. They work out their ideas with some precision, taking into account how products will be used, who will use them, how much they cost and their appearance. They develop their understanding of designing and making by investigating products and finding out about the work of professional designers and manufacturing industry. They use computers, including computer-aided design and manufacture (CAD/CAM) and control software, as an integral part of designing and making. They draw on knowledge and understanding from other areas of the curriculum.

### Knowledge, skills and understanding

***1. Developing, planning and communicating ideas.***

Pupils should be taught to:

a. Identify relevant sources of information, using a range of resources including ICT
b. Respond to design briefs and produce their own design specifications for products
c. Develop criteria for their designs to guide their thinking and to form a basis for evaluation
d. Generate design proposals that match the criteria
e. Consider aesthetics and other issues that influence their planning
f. Suggest outline plans for designing and making, and change them if necessary
g. Prioritise actions and reconcile decisions as a project develops, taking into account the use of time and costs when selecting materials, components, tools, equipment and production methods
h. Use graphic techniques and ICT, including computer-aided design (CAD), to explore, develop, model and communicate design proposals

***2. Working with tools, equipment, materials and components to produce quality products***

When designing and making, pupils should be taught:

a. To select and use tools, equipment and processes, including computer-aided design and manufacture (CAD/CAM), to shape and form materials safely and accurately and finish them appropriately
b. To take account of the working characteristics and properties of materials and components when deciding how and when to use them
c. To join and combine materials and ready-made components accurately to achieve functional results
d. To make single products and products in quantity, using a range of techniques, including CAD/CAM to ensure consistency and accuracy
e. About the working characteristics and applications of a range of modern materials, including smart materials.

***3. Evaluating processes and products***

When designing and making, pupils should be taught to:

a. Evaluate their design ideas as these develop, and modify their proposals to ensure that their product meets the design specification
b. Test how well their products work, then evaluate them
c. Identify and use criteria to judge the quality of other people's products, including the extent to which they meet a clear need, their fitness for purpose, whether resources have been used appropriately, and their impact beyond the purpose for which they were designed

#### *4. Knowledge and understanding of materials and components*

Pupils should be taught:

a. To consider physical and chemical properties and working characteristics of a range of common and modern materials
b. That materials and components can be classified according to their properties and working characteristics
c. That materials and components can be combined, processed and finished to create more useful properties and particular aesthetic effects
d. How multiple copies can be made of the same product.

#### *5. Knowledge and understanding of systems and control*

Pupils should be taught:

a. To recognise inputs, processes and outputs in their own and existing products
b. That complex systems can be broken down into sub-systems to make it easier to analyse them, and that each sub-system also has inputs, processes and outputs
c. The importance of feedback in control systems
d. About mechanical, electrical, electronic and pneumatic control systems, including the use of switches in electrical systems, sensors in electronic switching circuits, and how mechanical systems can be joined together to create different kinds of movement
e. How different types of systems and sub-systems can be interconnected to achieve a particular function
f. How to use electronics, microprocessors and computers to control systems, including the use of feedback
g. How to use ICT to design sub-systems and systems.

#### *6. Knowledge and understanding of structures*

Pupils should be taught:

a. To recognise and use structures and how to support and reinforce them
b. Simple tests and appropriate calculations to work out the effect of loads
c. That forces of compression, tension, torsion and shear produce different effects.

#### *7. Breadth of study*

During the key stage, pupils should be taught the knowledge, skills and understanding through:

a. Product analysis
b. Focused practical tasks that develop a range of techniques, skills, processes and knowledge
c. Design and make assignments in different contexts. The assignments should include control systems, and work using a range of contrasting materials, including resistant materials, compliant materials and/or food.

## Acknowledgements

Rapid Electronics would like to thank the many teachers and organisations that have helped in the development and evaluation of this project. In particular we would like to thank the British Vintage Wireless Society for the images and advice used in these notes.

If your school has a project it is willing to share, or would like to help evaluate new teaching material, then please contact the Education Section at Rapid Electronics.